

**WRITTEN AMENDMENT**

(Amendment under the provision of Section 11 of the Law)

Examiner of the Patent Office: Mr. YOSHIKAWA, Eiichi

**1. Indication of International Application:**

PCT/JP03/13497

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**4. Subject of the Amendment:**

Description and claims

**5. Contents of the Amendment:**

(a) Page 3, lines 28 to 29 of the description (corresponding to page 7, lines 13 to 14 of the translation), amend "and then crosslinking the foregoing thermoplastic polymer by heating or radiations" to -- and containing at least the foregoing trifunctional crosslinking agent as the foregoing cross-

linking agent, with the content of the foregoing crosslinking agent being from 0.5 to 10 parts by weight based on 100 parts by weight of the foregoing thermoplastic polymer --.

(b) Page 4, lines 1 to 2 of the description (corresponding to page 7, lines 18 to 20 of the translation), amend "it is possible to improve heat resistance and mechanical strength. Further, by using the inorganic filler" to -- it is possible to improve heat resistance and mechanical strength. By using a crosslinking agent containing at least a trifunctional crosslinking agent, it is possible to form a uniform three-dimensional network structure, thereby making the resin molded article have more excellent heat resistance and mechanical strength. And, by containing the crosslinking agent in an amount of from 0.5 to 10 parts by weight based on 100 parts by weight of the thermoplastic polymer, it is possible to keep the mechanical strength of the molded article and improve the dimensional stability. Further, by using the inorganic filler --.

(c) Page 4, lines 30 to page 5, line 3 of the description (corresponding to page 10, lines 8 to 15 of the translation), delete "According to a preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that at least the foregoing trifunctional crosslinking agent is contained as the foregoing crosslinking agent. In this way, a uniform

three-dimensional network structure is formed, and therefore, a resin molded article which is excellent in the foregoing physical properties is obtained".

(d) Page 6, lines 3 to 6 of the description (corresponding to page 12, lines 18 to 25 of the translation), delete "According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing crosslinking agent is contained in an amount of from 0.5 to 10 parts by weight based on 100 parts by weight of the foregoing thermoplastic polymer. In this way, not only the mechanical strength of the molded article can be kept, but also the dimensional stability is improved".

(e) Page 27, claim 1 (corresponding to page 56, claim 1 of the translation), amend "and then crosslinking said thermoplastic polymer by heating or radiations" to -- and containing at least said trifunctional crosslinking agent as said crosslinking agent, with the content of said crosslinking agent being from 0.5 to 10 parts by weight based on 100 parts by weight of said thermoplastic polymer --; and cancel claims 2 and 6.

#### 6. List of Attached Documents:

(a) Pages 3 to 6 of the description (corresponding to pages 5 to 15 of the translation)

(b) Page 27 of the claims (corresponding to pages 56 to  
57 of the translation)

and curing it with the silane coupling agent.

Further, it is studied by JP-A-47-41745 and JP-A-51-39750 that a melamine derivative, cyanuric acid, or isocyanuric acid is blended as a flame retarder, thereby imparting flame retardancy to a polyamide resin.

However, among the foregoing conventional technologies, in the thermoplastic resin molded articles employing crosslinking with radiations as disclosed in JP-A-57-119911, JP-A-59-12935, and JP-A-61-7336, shrinkage or resin decomposition by crosslinking and curing was likely caused, whereby deformation likely occurred. Also, during kneading into the resin or molding, there was the possibility that the crosslinking assistant is vaporized to cause foaming or that the composition changes to cause gelation. Further, there was encountered a problem that the surface of a mold is stained to cause deterioration of the molding properties, whereby a thin-walled and precise molded article is not obtained. Moreover, there was encountered a problem that during adding a flame retardant or the like, bleed-out is caused, whereby a uniform resin composition is not obtained.

Also, when used as molded parts such as the foregoing electromagnetic switch, connector or breaker, there was the possibility that an unreacted monomer or a decomposed gas of the crosslinking agent is generated by the crosslinking with radiations, bleed-out of an oligomerized material takes place,

thereby causing metallic staining of electrodes, etc., or attachment takes place at the time of driving, thereby causing an erroneous actuation. Further, there was encountered a problem that mechanical characteristics such as abrasion resistance are lowered, or a dimensional change is caused.

Also, in the resin compositions for performing crosslinking and curing by a thermal catalyst or a silane coupling agent as disclosed in JP-A-2001-40206 and JP-A-2002-265631, the crosslinking reaction partly proceeds even by heating in a mold at the time of injection molding. For that reason, there was encountered a problem that it is difficult to control the crosslinking, or a spool portion that is excessive at the time of molding cannot be recycled.

Also, in imparting flame retardancy by blending a melamine derivative, cyanuric acid, or isocyanuric acid as disclosed in JP-A-47-41745 and JP-A-51-39750, there was encountered a problem that the resulting molded article is not sufficient in heat resistance, dimensional change, and mechanical characteristics.

#### DISCLOSURE OF THE INVENTION

Accordingly, an object of the invention is to provide a resin molded article for electric part, which is excellent in heat resistance, mechanical characteristics, electric characteristics, dimensional stability, flame retardancy,

and molding properties, which can be suitably used especially as a member for supporting a contact of electromagnetic switch, a housing, and the like, and which is suitable for injection molding using a thermoplastic resin and a production process of the same.

For the sake of solving the foregoing problem, the resin molded article for electric part of the invention is characterized by one resulting from molding and solidifying a resin composition containing a thermoplastic polymer, a crosslinking agent comprising a polyfunctional monomer or oligomer containing an unsaturated group in ends of the major skeleton, an inorganic filler, and a reinforcing fiber, then crosslinking the foregoing thermoplastic polymer by heating or radiations, and containing at least the foregoing trifunctional crosslinking agent as the foregoing crosslinking agent, with the content of the foregoing crosslinking agent being from 0.5 to 10 parts by weight based on 100 parts by weight of the foregoing thermoplastic polymer.

According to the resin molded article for electric part of the invention, by subjecting the major component polymer to crosslinking reaction by heating or radiations into a three-dimensional network structure, it is possible to improve heat resistance and mechanical strength. By using a crosslinking agent containing at least a trifunctional crosslinking agent as a crosslinking agent, it is possible to

form a uniform three-dimensional network structure, thereby making the resin molded article have more excellent heat resistance and mechanical strength. And, by containing the crosslinking agent in an amount of from 0.5 to 10 parts by weight based on 100 parts by weight of the thermoplastic polymer, it is possible to keep the mechanical strength of the molded article and improve the dimensional stability. Further, by using the inorganic filler and the reinforcing fiber in combination, it is possible to obtain a resin molded article which is suppressed in shrinkage and decomposition due to the crosslinking and which is excellent in all of chemical stability, heat resistance, mechanical characteristics, electric characteristics, dimensional stability, flame retardancy, and molding properties. Moreover, it becomes possible to achieve thin-walled molding processing.

Also, in the case of crosslinking with radiations, since the crosslinking reaction does not proceed at all at the time of heat molding such as injection molding, it is possible to recycle a spool portion that is excessive at the time of molding as thermoplastic resins.

On the other hand, the production process of a resin molded article for electric part of the invention is characterized by including an adsorbing step for adsorbing a crosslinking agent comprising a polyfunctional monomer or oligomer containing an unsaturated group in ends of the major



skeleton onto an inorganic filler; a kneading step for kneading a resin composition containing the inorganic filler after the adsorption, a thermoplastic polymer, and a reinforcing fiber; a step for injecting molding the foregoing kneaded resin composition; and a crosslinking step for taking out the foregoing resin composition after the injection step from a mold and heating it or irradiating it with radiations.

According to this production process, it is possible to perform the same molding as in usual thermoplastic resins using an injection molding machine. Further, after the injection, by performing crosslinking by heating or radiations, the crosslinking reaction is accelerated, thereby advancing curing. Accordingly, it is possible to produce a resin molded article having excellent mechanical strength, heat resistance and flame retardancy with good productivity.

Also, after adsorbing the crosslinking agent onto the inorganic filler, the resulting inorganic filler is kneaded with the thermoplastic polymer and the reinforcing filler, and therefore, dispersion of the crosslinking agent is performed uniformly. In this way, physical properties of the resulting resin molded article become uniform. Thus, it is possible to obtain a resin molded article which is excellent in all of heat resistance, mechanical characteristics, electric characteristics, dimensional stability, flame retardancy, and molding properties.

Incidentally, in the case of performing the crosslinking step upon irradiation with radiations, it is preferred to irradiate electron beams or  $\gamma$ -rays having a dosage of 10 kGy or more. In this way, it is possible to prevent heterogeneous formation of a three-dimensional network structure due to a shortage of the dosage or bleed-out due to the unreacted residual crosslinking agent. Also, in particular, when the irradiation dosage is from 10 to 45 kGy, it is possible to prevent deformation or shrinkage or the like due to an internal strain of the resin composition caused by an oxidation decomposition product which is generated by an excess of the dosage, thereby obtaining a resin molded article which is excellent in the foregoing physical properties.

Also, in the case of performing the crosslinking step by heating, it is preferred to perform heating at a temperature of at least 5 °C higher than the temperature of the foregoing injection molding. In this way, a unit for irradiating radiations or the like is not necessary, and in particular, this crosslinking step can be suitably employed for a thermosetting resin-containing resin composition.

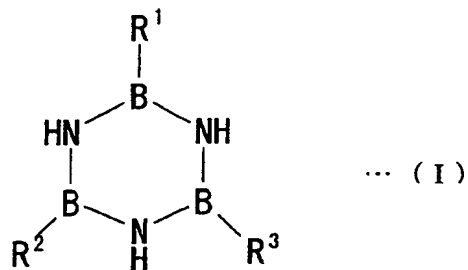
According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that two or more kinds of the foregoing polyfunctional crosslinking agent are used in combination as the foregoing crosslinking agent. In

this way, for example, by using crosslinking agents having different reactivity, such as an allylate and an acrylate, in combination, a reaction rate required for crosslinking can be controlled, and therefore, it is possible to prevent shrinkage of the resin molded article due to rapid progress of the crosslinking reaction. Also, for example, by using the foregoing bifunctional crosslinking agent and the foregoing trifunctional crosslinking agent in combination, a reaction rate required for crosslinking can be controlled, too, and therefore, it is possible to prevent shrinkage of the resin molded article due to rapid progress of the crosslinking reaction.

According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing thermoplastic polymer is a polyamide based resin and that the major skeleton of the foregoing crosslinking agent is an N element-containing cyclic compound. In this way, since the compatibility of the amide group with the N element is more enhanced, the compatibility with the polyamide based resin is improved. Also, since the N element-containing cyclic compound that is the crosslinking agent has flame retardancy itself, the flame retardancy of the resin molded article is improved.

According to a more preferred embodiment of the resin

molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing crosslinking agent is a compound represented by the following general formula (I).



(In the formula (I),  $R^1$  to  $R^3$  each represents a group selected from  $-\text{O}-R^4-\text{CR}^5=\text{CH}_2$ ,  $-\text{R}^4-\text{OOC}-\text{CR}^5=\text{CH}_2$ ,  $-\text{R}^4-\text{CR}^5=\text{CH}_2$ ,  $-\text{HNOC}-\text{CR}^5=\text{CH}_2$ , and  $-\text{HN}-\text{CH}_2-\text{CR}^5=\text{CH}_2$ .  $R^4$  represents an alkylene group having from 1 to 5 carbon atoms.  $R^5$  represents hydrogen or a methyl group.  $R^1$  to  $R^3$  may be the same or different.)

Since the foregoing compound contains boron and the boron atom has a large atomic radius, a crosslinking effect becomes large so that it is possible to further improve the mechanical strength and heat resistance of the resulting molded article. Also, since the compatibility with the resin is good, the molding properties are not lowered. Further, since the foregoing compound itself has an effect as a flame retardant assistant, it can be especially suitably used in the invention.

According to a more preferred embodiment of the resin molded article for electric part and the production process

of the same of the invention, it is preferable that the foregoing reinforcing fiber is contained in an amount of from 5 to 40 % by weight based on the whole of the foregoing resin composition and that the foregoing reinforcing fiber is a glass fiber the surface of which has been treated with a resin. By containing the reinforcing fiber, it is possible to improve tensile, compression, bending and impact strengths and other mechanical strengths, and further, it is possible to prevent a lowering of physical properties against water or the temperature. Also, since the glass fiber the surface of which has been previously treated with a resin is used, adhesion to the thermoplastic polymer is improved.

According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing inorganic filler is contained in an amount of from 1 to 15 % by weight based on the whole of the foregoing resin composition. In this way, not only the mechanical strength of the molded article can be kept so that the dimensional stability is improved, but also it is possible to prevent the generation of cracks and the like caused by the matter that the resin molded article becomes brittle due to excessive containing.

According to a more preferred embodiment of the resin molded article for electric part and the production process

of the same of the invention, it is preferable that stratiform clay having a silicate layer laminated therein is contained as the foregoing inorganic filler and that the foregoing stratiform clay is contained in an amount of from 1 to 10 % by weight based on the whole of the foregoing resin composition. In this way, when the stratiform clay is dispersed at the nano-order level in the resin, a hybrid structure with the resin is formed. In this way, the heat resistance and mechanical strength and the like of the resulting flame retardant resin processed article are improved.

According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing resin composition contains a flame retarder and that the subject flame retarder is contained in an amount of from 2 to 35 % by weight based on the whole of the foregoing resin composition. By making the content fall within the foregoing range, not only the flame retardancy can be improved, but also bleed-out and failure of crosslinking due to the excessive addition can be prevented, whereby when used as an electromagnetic switch, it is possible to prevent a lowering of the durability or electric characteristics or the like.

According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that a

monofunctional organophosphorus compound containing one unsaturated group in the end thereof is contained as the foregoing flame retarder. In this way, since the flame retarder reacts with and bonds to the resin, it is possible to prevent bleed-out of the flame retarder, whereby deterioration with time of the flame retardant effect can be prevented. Also, even when the addition amount is small, it is possible to obtain a high flame retardant effect.

According to a more preferred embodiment of the resin molded article for electric part and the production process of the same of the invention, it is preferable that the foregoing electric part is used for an electromagnetic switch. In an electromagnetic switch, for example, for the sake of supporting a contact, a resin molded article is used. The resin molded article is required to have high strength, heat resistance, flame retardancy, and dimensional stability and the like such that it is durable against heat generated in the contact and a repeated action of the contact, and therefore, the resin molded article and the production process of the same of the invention are especially effective.

## CLAIMS

1. A resin molded article for electric part, which is characterized by one resulting from molding and solidifying a resin composition containing a thermoplastic polymer, a crosslinking agent comprising a polyfunctional monomer or oligomer containing an unsaturated group in ends of the major skeleton, an inorganic filler, and a reinforcing fiber and then crosslinking said thermoplastic polymer by heating or radiations and containing at least said trifunctional crosslinking agent as said crosslinking agent, with the content of said crosslinking agent being from 0.5 to 10 parts by weight based on 100 parts by weight of said thermoplastic polymer.

2. (Cancelled)

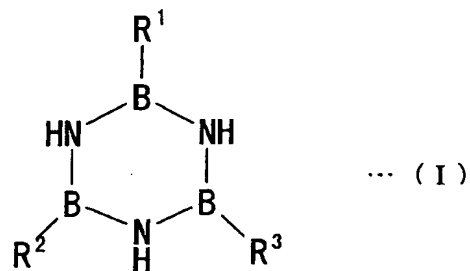
3. The resin molded article for electric part according to claim 1 or 2, wherein two or more kinds of said polyfunctional crosslinking agent are used in combination as said crosslinking agent.

4. The resin molded article for electric part according to any one of claims 1 to 3; wherein said thermoplastic polymer is a polyamide based resin, and the major skeleton of said crosslinking agent is an N element-containing cyclic compound.

5. The resin molded article for electric part



according to any one of claims 1 to 4, wherein said crosslinking agent is a compound represented by the following general formula (I):



wherein  $R^1$  to  $R^3$  each represents a group selected from  $-O-R^4-CR^5=CH_2$ ,  $-R^4-OOC-CR^5=CH_2$ ,  $-R^4-CR^5=CH_2$ ,  $-HNOC-CR^5=CH_2$ , and  $-HN-CH_2-CR^5=CH_2$ ;  $R^4$  represents an alkylene group having from 1 to 5 carbon atoms;  $R^5$  represents hydrogen or a methyl group; and  $R^1$  to  $R^3$  may be the same or different.

6. (Cancelled)

7. The resin molded article for electric part according to any one of claims 1 to 6, wherein said reinforcing fiber is contained in an amount of from 5 to 40 % by weight based the whole of said resin composition, and said reinforcing fiber is a glass fiber the surface of which has been treated with a resin.

8. The resin molded article for electric part according to any one of claims 1 to 7, wherein said inorganic filler is contained in an amount of from 1 to 15 % by weight based on the whole of said resin composition.

9. The resin molded article for electric part